Towards a modular superparameterization for Stratocumulus clouds considering unsteady entrainment

H. Schmidt1,2, J. P. Mellado1, N. Peters1, and B. Stevens1

1Institute of Applied Mechanics, Technische Universität Berlin, Berlin, Germany
2German Center for Aeronautics Research, Munich, Germany

Abstract

Large scales and Multi Scale Coupling (ZIB)

Large Scales: Clustering of kinetic energy over a large scale eddy ($k = 800m$), $40^\circ - 0^\circ$, $20^\circ - 10^\circ$)

Small Scales: Changes across the viscous superlayer $\Delta \Theta$ (e.g. $\Delta \Theta = 10^\circ$)

Scale Relation: $\Delta \Theta \gg \Delta \Theta_0 = 0$)

Accurate large-scale control of the prognostic variables is important. This is a necessary condition for embedding a subgrid model that is driven by the large scales and has significant feedback on them at the same time. There are analogies to combustion and two phase flow modeling, but poorly explored.

Evolution of the Interface

As $\Delta t \to 0$, the subgrid scale turbulence kinetic energy $e_{s,0}$ is given by the subgrid scale turbulence kinetic energy $e_{s,0} = e_{s,0}(x, t)$.

Flow Equations and Codes

We are implementing the Heterogeneous Multiscale Model (HMM) from [9] into the institute UCLA-LES solver [5]. Comparison with DYCOMS-II [21] is our goal.

Subgrid Scale Entrainment Modeling

One dimensional turbulence model: $\frac{d\theta}{dt} = \frac{\Delta t}{\Delta x} \theta$ (1)

Global entrainment velocity is defined as temporal change of a mixing region thickness $\Delta x$.

Entrainment Model

Global entrainment velocity is defined as temporal change of a mixing region thickness $\Delta x$.

Buoyancy Reversal

The two-layer system of hot/dry air on top of cold/moist air can have buoyancy reversal instability due to evaporative cooling. Central figure below represents the perturbed initial condition: the stable mode develops a turbulent mixing region around the central position due to baroclinic production of vorticity. Time scale of the overturning mode is $\tau = 8 \times 10^3 s$.

References